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PROJECTIONS OF THE DEMAND FOR SKIING IN COLORADO

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IN COLORADO

by

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EXPERIMENT STATION

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INTRODUCTION

Colorado skiing is becoming increasingly popular. Statistics indicate that skiing in the State has increased at a 14 percent annual growth rate since 1970. In 1975, Colorado's ski resorts recorded an all-time high of 5.9 million visits.

The rapid growth rates prompted the Forest Service--which is responsible for approving new ski areas on National Forests--to ponder Colorado's ski future. If the demand for Colorado's slopes continues to increase at current rates, present ski operations would inadequately meet future needs. The public eventually would associate Rocky Mountain skiing with crowds and endless lift lines. If ski resorts expand too rapidly, the overbuilding would result in excessive ski slopes and lower returns to investors.

Aware of the need for future planning, a Forest Service General Management Review recommended that Region Two develop a method for projecting skiing demand. The Review wanted to know the number of skiers Colorado should expect to accommodate. This report discusses methods for finding the answer.

The Forest Service Regional Office, located in Lakewood, Colorado, developed the following report based on Forest Service statistics and data compiled by other researchers.

Predicting Colorado's ski demand is a complex problem which has no simple answer. Numerous factors--or variables--can influence the future demand for Colorado's slopes. It is important to consider as many variables as possible.

WHAT IS DEMAND?

To the lay person, demand means "use." For example, ski demand means the number of skiers, or the number of lift tickets sold. To economists, demand is the amount of use at different prices. At higher prices, the number of lift tickets sold would be expected to decline. Conversely, lower prices could mean increased skiing. This principle applies not only to prices but also to factors such as skier age, proficiency, education, and income. Other influences include population, vertical transport feet (VTF)--or lift capacity, and past use trends.

There are many methods for analyzing use trends. This report discusses five methods which range from a simple projection of past Colorado ski industry growth to complex econometric analysis. The methods include:

1. Projecting skier use figures based on past growth rates in the Colorado ski industry.

2. Charting skier use trend lines (on a graph) based on the number of visits to ski resorts in past years. This technique is called simple regression analysis.

3. Analyzing population trends, number of times skiers ski per year, and amount of skiing per day based on skier proficiency.

4. Simultaneously analyzing several variables such as lift capacity, lift ticket price, year, skier education levels, and disposable income. This technique is called multiple regression analysis.

5. Using an advanced econometric analysis that takes into account the fact that some of the independent variables--like price or lift capacity--are jointly determined with the main dependent variable which is number of visits. This technique, which is called three-stage-least-squares, provides a method of analyzing variables when they are not independent.

PROJECTIONS BY PAST GROWTH RATES

Skiing use can be estimated by projecting past Colorado ski industry growth rates. (See Table 1.) For example, the increase in lift ticket sales from 443,000 in 1960 to 5.9 million in 1975-76 represents an 18 percent annual growth rate. Assuming future increases will continue at this rate, lift ticket sales would be projected to reach 13.7 million in 1980-81 and 31.3 million in 1985-86.

About 2.7 million lift tickets were sold in 1969 compared to 6 million in 1976, representing an annual growth rate of about 14 percent. Projecting the 14 percent growth rate indicates ski resorts could expect to sell about 11.5 million lift tickets in 1980-81 and 22.1 million in 1985-86.

Such a wide discrepancy--the difference between 22.1 and 31.3 million lift ticket sales in 1985--raises doubts about the accuracy of projections by growth rates.

PROJECTIONS OF PAST TRENDS

Skiing use can be projected by fitting a trend line to the number of lift tickets sold each year. Chart 1 shows projections of skier visits based on Forest Service lift ticket statistics for Colorado ski areas in recent years. Two types of lines are fitted to the data: a straight line and a

Table 1

NUMBER OF LIFT TICKETS ISSUED AT COLORADO SKI AREAS, GROWTH RATES, AND PROJECTIONS TO SELECTED PERIODS

Year	Lift Tickets Issued in Colorado (1000)	Growth Rate From Previous Year
1960-61	443	
61-62	558	1.259
62-63	552	0.989
63-64	805	1.458
64-65	1107	1.375
65-66	1172	1.059
66-67	1414	1.206
67-68	1814	1.283
68-69	2338	1.289
69-70	2751	1.176
70-71	3003	1.092
71-72	3267	1.088
72-73	3980	1.218
73-74	4310	1.083
74-75	5201	1.207
75-76	5972	1.148
Average		1.195
Weighted average		1.18

Rate of growth 1960-61 to 1975-76 = 443.7 X^{15} = 5972
X = 1.189

Rate of growth 1965-66 to 1975-76 = 1172 X^{10} = 5972
X = 1.177

Rate of growth 1969-70 to 1975-76 = 2751 X^{6} = 597
X = 1.138

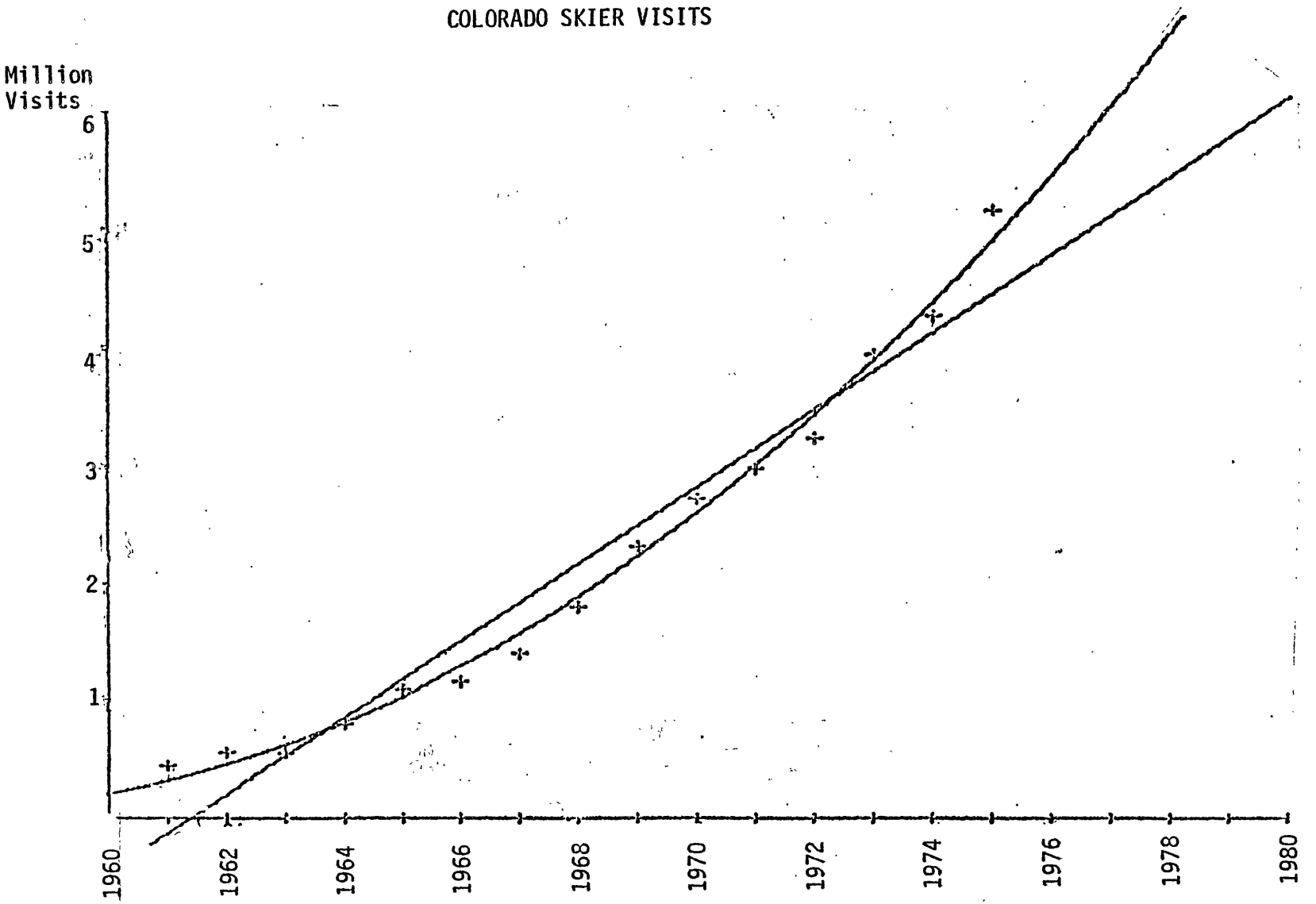
Rate of growth 1974-75 to 1975-76 = 5201 X = 5972
X = 1.148

Rate of growth 1972-73 to 1975-76 = 3980 X^{3} = 5972
X = 1.145

1.14^{5} x 5,972,000 = 11,499,000 in 1980-81
1.14^{10} x 5,972,000 = 22,139,000 in 1985-86
1.18^{5} x 5,972,000 = 13,662,489 in 1980-81
1.18^{10} x 5,972,000 = 31,256,466 in 1985-86

Chart 1

COLORADO SKIER VISITS



curve. The regression lines are based on data from 1960-61 through 1974-75. The curve projects the 5.9 million visits in the 1975-76 season more accurately than the straight line. The chart shows only trends over time. However, factors other than trends affect ski demand, as the following discussion will illustrate.

NUMBER OF SKIERS, NUMBER OF VISITS PER YEAR, AND SKIER PROFICIENCY

These three variables account for total use at a ski area. However, only the first two account for the number of lift tickets sold. It is important to recognize that number of the lift tickets sold does not account for the additional skiing done by more proficient skiers. Factors affecting these variables will be analyzed separately.

POPULATION EFFECTS

Out-of-Staters constitute a significant portion of skiers in Colorado. In Aspen, for example, 93 percent of the skiers live in other States. It is therefore important to examine trends in the entire U.S. population.

The U.S. population aged 18 to 34 (an age group that includes most active skiers) is projected to increase from 60.2 million in 1976 to 65.5 million in 1980 and 67.7 million in 1985. This indicates a growth rate of 2.17

percent per year between 1976 and 1980 and a growth rate of 1.31 percent per year between 1976 and 1985 (see Table 2). The growth rate in the population of 18- to 34-year-olds was 3.14 percent per year between 1970 and 1976. Although the rate of growth has declined, the number of persons added each year has increased. Between 1970 and 1971, 1.64 million were added to the 18-34 age group. Between 1975 and 1976, 1.69 million were added to this age group. It is expected that 1.34 million persons will be added between 1980 and 1981.

Clearly, factors other than U.S. population growth rates in the 18 to 34 age bracket must be responsible for the 14 to 18 percent growth rates in the Colorado ski industry. Changes in the Colorado population will be examined next.

EFFECTS OF COLORADO POPULATION GROWTH

The Colorado population aged 20-24 is expected to increase at an annual growth rate of 3.7 percent from 1970 to 1980 (under the "high" assumption about growth trends), compared to the 2.17 percent annual increase projected for the national population of 18- to 34-year-olds. The estimated number of skiers living in Colorado is expected to increase from 294,524 in 1970 to 384,714 in 1980--a growth rate of 2.7 percent. (These figures are the totals of the percentage of skiers in different age groups, multiplied by the population in those age groups.) (See Table 3.) Again, this projected growth trend in Colorado's population does not match the 14 percent increase in skiers registered in recent years.

Table 2

U.S. POPULATION IN AGE GROUP 18-34 YEARS
THROUGH 1990

Year	Population	Year	Population
1962	40,181	1977	61,761
1963	40,679	1978	62,900
1964	41,180	1979	64,274
1965	42,750	1980	65,598
1966	44,101	1981	66,936
1967	45,483	1982	67,180
1968	46,873	1983	67,526
1969	48,403	1984	67,649
1970	49,976	1985	67,680
1971	51,615	1986	67,498
1972	53,298	1987	67,279
1973	54,986	1988	67,056
1974	56,678	1989	66,819
1975	58,503	1990	66,124
1976	60,191		

SOURCE: Department of Commerce, Bureau of Census

Table 3

COLORADO POPULATION BY AGE GROUPS 1970
AND 1980 AND NUMBER OF SKIERS
BY AGE GROUPS

Age	7/1/70*	Percent of Residents Who Ski in Age Group**	Estimated No. of Resident Skiers	High Series 1980	Percent of Residents Who Ski in Age Group	Estimated No. of Resident Skiers
0-4	187,826			223,233		
5-9	225,925	10	22,592	224,453	10	22,445
10-14	235,509	30	136,399	239,099	30	150,070
15-19	219,154			261,134		
20-24	206,110	25	51,527	316,518	25	79,130
25-29	158,652	12	19,038	288,761	12	34,651
30-34	134,829	8	10,786	257,337	8	20,587
35-39	128,111			219,268		
40-44	129,513	12	46,020	183,134	12	67,356
45-49	125,881			158,898		
50-54	110,151	4	8,162	140,358	4	10,475
55-59	121,524			121,524		
	TOTAL		294,524			384,714

TOTAL ALL AGES: 2,224,529

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* Source: David E. Monarchi, Colorado Regional and County Population Estimates, 1970-1980, Vol. II, Business Research Division, University of Colorado, Boulder, Colorado.

** The percentage who ski in each age group came from the 1968 Denver Research Institute Study. Age group percentages were adjusted to account for the reported brackets. The main adjustment was that 10 percent are assumed to come from the 5-9 age group in this table. In the study, 10 percent came from the "12 and under" age group.

There are drawbacks in estimating increases in skiers based on population growth rates. For example, persons who started skiing as youngsters will probably be enjoying the sport as adults. Using only the present percentages in each age group ignores this variable. In order to project future demands for Colorado's ski industry, it is necessary to consider other variables such as the number of times skiers ski per year.

NUMBER OF TIMES SKIERS SKI PER YEAR

The most comprehensive study of Colorado skiing was done by the Denver Research Institute (DRI) in 1968. According to the 1968 telephone survey of Colorado residents, the average Coloradan who skied in 1968 took nine trips totaling 14 days of skiing. Results indicate 10 ski days for heads of households who were 17-24 years old, 27 days for heads of households aged 25-34, and 1 skier day for those 55-64 years old.

The number of ski days of Coloradans was also related to income:

Income	Skier Days
Under $5,000	1.0
$5,000 - $7,499	18.5
$7,500 - $9,999	9.2
$10,000 - $14,999	10.9
$15,000 and Over	35.6

People with household incomes over $15,000 skied almost four times as much as those in the $7,500 to $9,999 category and over three times as much as

$10,000 to $14,999 households. The large amount of skiing by households with incomes of $5,000 to $7,500 might be explained by a relatively large number of younger people in this income group.

The number of days spent skiing per year is shown in later studies. Results of these studies will be compared with the number of skier days shown above. (See Table 4.)

Two studies generated data on number of skier days at two State resorts. "The Winter Park Skier Market 1974-75: A Market Research Study," by Ted Farwell and the Business Research Division at the University of Colorado (CU) show that Coloradans skied 19 days per year at Winter Park. Dr. C. R. Goldner of the CU Business Division conducted a lift survey which also estimates about 19 days of skiing per year for Aspen skiers. A comparison between the 1974-75 Winter Park study and the 1968 DRI study indicates that Coloradans might have increased their skiing from 14 to 19 days per year during this period.

PROFICIENCY OF SKIERS

Proficiency dictates the slopes persons will ski and the amount of skiing they will accomplish a day. The 1968 DRI report and two studies made in 1974-75 offer breakdowns in skiers abilities (see Table 5).

Table 4

NUMBER OF TIMES PEOPLE SKI AS REPORTED
IN DIFFERENT STUDIES

No. of Days Skiing Per Year	Year of Survey and Source of Data*					
	1973-74 Aspen Skier	1971-72 Aspen Skier	1974 Airlines Survey	Winter Park - 1974-75		
				Total	Coloradans	Out-of-State
	(Percent)					
3 or less	00.8	00.2	03.6	-	-	-
4-5	03.3	02.5	04.7	-	-	-
6-7	11.1	08.5	11.4	-	-	-
8-10	12.4	09.3	16.3	-	-	-
11-14	18.5	17.4	20.7	-	-	-
15-21	20.0	23.4	20.4	-	-	-
22-28	09.8	14.2	08.2	-	-	-
Over 28	24.0	24.4	14.1	-	-	-
TOTAL	18.76	19.98	15.73	18.5	19.0	14.3

* The Winter Park study is not directly comparable with the Aspen studies because the Aspen studies asked for ranges in number of days and the Winter Park study gave the total number of days per season. The total number of ski days for Aspen was estimated by taking the midpoint of the range times the percentage and estimating 35 days for those who skied over 28 days. (This method could lead to error because of the guess on the number of days skied by the large percentage who skied over 28 days.)

Table 5

COMPARISONS OF SKIER PROFICIENCY

Denver Research Institute Study
(Mail Questionnaire) 1968

	Total (Percent)	Colorado Adults (Percent)	Out-of-State Adults (Percent)	All Students (Percent)
Novice	11.0	11.6	10.5	11.7
Intermediate	52.1	51.6	55.5	48.7
Advanced	35.8	35.8	33.7	39.5
No answer	1.1	1.0	0.3	0.2

	Aspen Lift Study 1974-1975 (Percent)	Winter Park Study 1974-1975 (Percent)		
		All Skiers	Colorado Skiers	Out-of-State Skiers
Novice	2.0	0.7	1.1	--
Beginner	3.6	3.4	4.3	1.9
Low Intermediate	25.5	9.5	7.4	9.6
Intermediate		21.6	18.1	28.8
High Intermediate	43.4	35.1	34.0	38.5
Advanced	17.7	25.0	29.8	17.3
Expert	7.8	4.7	5.3	3.8

It is difficult to compare the Aspen, Winter Park, and DRI studies because each uses different categories. However, the beginner and novice categories in Aspen and Winter Park studies are only about 5 percent compared to 10 or 12 percent in the DRI report. The percentage of high, intermediate, advanced, and expert skiers in 1974-75 is considerably higher than the percentage of advanced skiers in the DRI study. The higher percentage could be due partly to difference in definition; but it appears the proficiency of skiers is increasing. About 25 to 30 percent classified themselves in the advanced and expert categories in 1974-75. Adding half the high-intermediate percentage to the advanced category indicates that 47.2 percent of the skiers at Aspen and Winter Park in 1974-75 were advanced, compared with 35.8 percent in the DRI report. This is a 12 percent increase in 6 years.*

If skier proficiency increases over time, it will probably create a need for additional lifts and advanced ski runs. The problem of additional area needs per skier is further accentuated by the fact that it takes more advanced slopes per expert skier than for beginners. Also, skiers perceive expert slopes to be more crowded, even though they are actually less so. Miss Coe Crum London summarized the problem as follows in the study, "Quality Skiing at Aspen, Colorado:"

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*However, the Winter Park study shows that only 14.6 percent of the skiers indicated that advanced and expert slopes were their "most favorite." About 26.4 percent said advanced and expert slopes were their "second favorite," but only 4.1 percent classified themselves as beginners or novices. About 11 percent of all skiers preferred beginner or novice slopes. Eight percent said that beginner and novice slopes were their "second favorite." The ranking of slopes might indicate that skiers tend to overclassify their skiing proficiency.

"Skiers' evalutions of use on each of the three (Aspen) mountains vary significantly and differ considerably from actual use statistics. For example, even though Buttermilk has the greatest number of skiers per acre, skiers believe the use is the lowest here of all three mountains. Likewise, skiers believe that Aspen Mountain is the most congested, even though actual density here is the lowest of the three mountains. These differences are explained by and point to the importance of the type of terrain affecting the carrying capacity. That is, the expert terrain of Aspen Mountain can accommodate a significantly lower number of people than the gentle terrain of Buttermilk."

An indication of the amount of area required by proficiency of skiers is based on the method used by planners at Aspen Skiing Corporation (IBID, p. 63).

"The present method of determining carrying capacity is by allocating a certain number of people per acre and basing the total skiing population on these figures. Specifically, they plan for 15 skiers per acre on novice terrain, 10 on intermediate terrain, and 5 on difficult terrain. These are generous guidelines compared to other U.S. ski areas, even though the method does not account for uneven distribution effect."

PROJECTIONS BASED ON POPULATION, NUMBER OF DAYS SKIED, AND PROFICIENCY

The number of ski days at all Colorado resorts in 1975-76 was 5.97 million. Studies indicate that persons skied an average of about 18.5 days per year. This would indicate that 322,811 people skied at Colorado areas. Dividing the number of Colorado skiers by the U.S. population of 18 to 34 year olds

indicates that only 0.536 percent of this age group skied in Colorado.* Multiplying the expected 1980 U.S. population aged 18 to 34 by 0.536 percent indicates 351,605 skiers. If they skied 18.5 days each, there would be 6.5 million ski visits in 1980-81.

If visits per skier continue to increase at the rate of one visit per year as they may have from 1968 to 1974, the number of days skied per year will increase to 23.5. The number of visits from the same population will be 8.26 million.

If proficiency continues to increase at about the 2 percent annual rate that occurred between 1968 and 1974, the following breakdown may exist:

Advanced intermediate level or above . . .	57 percent
Novices and beginners	6 percent
Intermediate	37 percent

The effects on required ski slope areas are shown below, using the rule of thumb of 15 skiers per acre on novice terrain, 10 per acre on intermediate terrain, and 5 per acre on difficult terrain:

	1974-75				1980-81			
	% of Skiers	Acres		Slope Area	% of Skiers	Acres		Slope Area
Novice, Beginner	0.06	x 1/15	=	0.004	0.06	x 1/15	=	0.004
Intermediate	0.47	x 1/10	=	0.047	0.37	x 1/10	=	0.037
Advanced	0.47/1.00	x 1/5	=	0.094	0.57/1.00	x 1/5	=	0.114
				0.145				0.155

* This assumes all skiers were 18-34 year olds.

If proficiency increased enough to shift 10 percent more skiers into the advanced skier category, the same number of skiers would require 6.9 percent more slope area.

MULTIPLE REGRESSIONS MODELS

Just as single regression models relate the dependent variable (lift tickets sold) to one independent variable such as price or year, multiple regression models develop equations relating the dependent variable to several independent variables simultaneously. Such a model, based on data from Colorado ski areas in the period from 1960-61 through 1974-75 gave the best fit of several models which were tried.

The Regression Equation Relating Lift Tickets Sold at All Colorado Ski Areas to Year, VTF, and Price is as follows:

$$T = 2{,}012{,}361 + 185{,}532\,Y + 23.65\,VTF - 591{,}256\,P$$

$$\text{Standardized } B = \quad + \quad 0.50\,Y + 0.62\,VTF - \quad 0.19\,P$$

$$R^2 = 0.98$$

Where: T = Lift Tickets Sold at All Colorado Ski Areas

Y = Year 1960-61 = 1 1975-76 = 16

VTF = Vertical Transport Feet (The number of people that can be transported 1,000 feet vertically by all lifts at an area in 1 hour)

P = Average Price of Adult Lift Tickets at All Colorado Ski Areas ÷ Consumer Price Index

R^2 = Coefficient of Determination. It indicates that 98 percent of the variability in lift tickets sold from 1960-61 through 1975-76 was explained by the equation.

Std. B^1 = Shows the relative importance of that variable in estimating T. Thus VTF with a B^1 of 0.63 is about three times as important in estimating T as Price with a B^1 of 0.19.

Substituting in values for the variables:

For 1975-76:

$$T = 2,013,461 + 185,532\ (16) + 23.65\ (153,780) - 519,256\ (\$5.99)$$

T = 5,508,526; Actual in 1975-76 was 5,971,907

For 1980-81, assuming VTF increases to the potential within present permit boundaries:

$$T = 2,013,461 + 185,532\ (21) + 23.65\ (194,827) - 519,256\ (\$5.99)$$

= 7,407,000. If the deflated price increased to $7, T would be 6,882,000.

For 1985-86, assuming VTF increases to the total potential expansion:

$$T = 2,013,461 + 185,532\ (26) + 23.65\ (255,069) - 519,256\ (\$5.99)$$

= 9,759,000. If the deflated price increased to $10, T would be 7,677,000.

The projection made by the above equation gives relatively lower predictions than projecting recent growth rates. One reason is that the equation underestimated 1975-76. Also, the equation does not account for other factors such as increased population and income, except as they were accounted for by "year" in the 1960 to 1975 period. It is always risky to go "beyond the data" in regression analysis.

REGRESSION ANALYSIS APPLIED TO AIRLINE SKIERS

A large percentage of skiers at Colorado ski resorts are from out-of-State. For example, a study by C. R. Goldner, The Aspen Skier, Vol. 1, Lift Survey indicated that only 7 percent of Aspen skiers were from Colorado. Many of these out-of-State skiers travel by air. In order to get a better understanding of this segment of demand for Colorado skiing, airline statistics were examined to determine where the skiers were from and if distance and cost of travel from their home influenced the percentage of the home city population that visited Aspen.

An example of demand as related to the Colorado ski industry is the number of people that fly to Aspen per million population from different U.S. cities related to the distance from Aspen. To make this analogy, the cost of flying is assumed to be the main variable cost. Table 6 shows the round trip ticket cost to Aspen from major U.S. cities and the number of people who flew to Aspen during the quarter ended March 31, 1975, together with a regression equation for 14 cities (omitting the two deviant cases of Houston

Table 6

COST OF AIRLINE ROUND TRIP TO ASPEN AND NUMBER OF VISITS PER MILLION POPULATION

City	Round Trip Ticket to Aspen 9-76	Airline Visits to Aspen per Million Population SMSA
Boston	$362	403
Chicago	226	847
Columbus	282	393
Dallas-Fort Worth	208	703
Houston	238	1,098
Kansas City	182	558
Los Angeles	234	276
Minneapolis	216	960
New Orleans	268	1,099
New York	344	409
Philadelphia	336	218
Phoenix	200	475
Pittsburg	300	142
St. Louis	228	313
San Franscisco	250	325
Washington, D.C.	324	437

All 16 cities:
Visits/Million = 1106.6 - 2.15 cost r^2 = 0.15 (Not significant)
Without Houston and New Orleans:
Visits/Million = 970.189-- 1.9295 Cost r^2 = 0.24 (Significant at = 0.95 percent Level

and New Orleans). It indicates that the number of visits per million population was:

$$\text{Visits} = 970 - 1.9 \times (\text{the round trip cost})$$

$$R^2 = 0.24 \text{ (significantly different from 0 at 5 percent level)}$$

This equation indicates that the number of visits to Aspen per million population in the city during the first quarter of 1975 was 970 minus 1.9, times the round trip airfare to Aspen. The equation shows the relationship between price and quantity of skiing but unfortunately explains only 24 percent of the variability in number of skiers from different cities.

THREE-STAGE-LEAST-SQUARES METHOD

Part of the problem of making projections is that vertical transport feet, lift tickets sold, and price are interrelated and therefore not independent. This violates the assumption of independence which is made in multiple regression analysis. Also, the independent variables were correlated with each other, price, VTF, and year increase simultaneously.

In an effort to get away from these problems, a model involving the econometric method of three-stage-least-squares was used.

Dr. George Sadler, Economist at the University of Southern Colorado, was hired to develop an econometric model using ski area data. He developed

and tested several simultaneous equation models. (A more detailed explanation of this method is presented in his paper, List of References, No. 7.)

Results of a three-stage-least-square, structural-equation model are presented in Table 7. It is pointed out that this model is extremely sensitive to changes in some of the variables, particularly population, occupation, and education.

This fact reduces the method's usefulness for making long-range projections because of the necessity for projecting the dependent variables forward with some accuracy. Notice the large differences in projections that result from relatively small changes in projected values of independent variables for 1980-81.

ALTERNATIVE METHODS FOR MAKING LONG-RANGE PROJECTIONS

In order to overcome the problems of longer range projections, Dr. George Sadler used a projection technique which gave a range of 7.1 to 9.3 million skier visits in Colorado in 1980-81 and 16 to 18 million visits in 1985-86. (See Appendix 1 for details of this method). One of his estimates for 1980 might be low because it is based on compounding from a 5-year average base period centered on the year 1973.

Table 7

THREE-STAGE-SQUARES-MODEL RELATING LIFT TICKETS TO OTHER VARIABLES (BASED ON 1960-1976 DATA)

$$L = -5.62 + 0.0262 (\text{Log } Y) + 2.520 (\text{Log } N) + 2.401 (\text{Log } O) + 5.146 (\text{Log } E) - 1.797 (\text{Log } I) - 1.008 (\text{Log } P)$$

Variable	Model Equation Values	Variable Value 1975	Log of 1975-76 Equation Value	1979-80 Variable Value	1980 Log of X Equation Value
Y = Year (1960=1 1975-76=16)	0.0262	16	0.0315	20	0.0341
N = U.S. Population 15-54	2.520	114.7	5.1901	121	5.2486
O = Occupation (Million)***	2.401	27.6	3.4596	29.53	3.5301
E = No. College Educated People in U.S. (Million)	5.146	11	5.3590	11.95	5.4410
I = Substitute Recreation Index**	-1.797	50	-3.0530	50	-3.0530
P = Price* (Equipment + Food + Lift Tickets)	-1.008	37.58	-1.5876	43.24	-1.6489
Constant	-5.625		-5.6250		-5.6250
L = Log of Lift Tickets Sold in Colorado			3.7746		3.9269
L = Estimated Lift Tickets (1000)			5951		8451
Actual Lift Tickets in 1975-76			5972		
Difference			-21		
Percent Error			0.35		

* Values for this endogenous (jointly determined) variable were computed as a function of all other variables in the model.

** This index was computed by dividing the index of total Winter Sports Visitor Days in Colorado by (the index of Skiing Lift Tickets Sold in Colorado plus the Winter Sports Index). Thus a relatively high index indicates that winter sports other than skiing were relatively more important in that year. The index varied from 47 to 63 in the 1960-76 period.

*** Millions of people in Professional, Administrative, Managerial, and Technical positions in the U.S.

If 7 years were used, the projection would be 11.9 million, giving a wider bracket of possible projections. Also, the formula could be modified to eliminate the negative variables of price and substitute recreation. If this were done, the projection would be 9.4 million in 1980-81, compounding for 7 years from the 1973 base, or 10.0 million compounding from the single year 5.97 million lift ticket base in 1975-76.

SUMMARY

A Forest Service General Management Review recommended that Region 2 develop a method of projecting the demand for skiing. Economists define demand as the schedule showing the amount of use at different prices. Analysis of airline visits to Aspen provides an equation showing visits related to cost of flying, which approximates a demand curve. It is important to make the distinction between use and demand because, in the past, use has been influenced by the supply of skiing offered. In the future, the growth could be more affected by the number of people wanting to ski. Price effects will continue to be important as a determiner of use.

Five methods of projecting skier visits are discussed in this report. They range from simple projections of past growth rate in the Colorado ski industry through simple regression analysis of population skier

visits per year and effects of increased skier proficiency, to multiple regression and three-stage-least-squares analysis.

Use of past 14 percent annual growth rates indicates 11.5 million skier visits in 1980-81 and 22.1 million visits in 1985-86. Although rates of 14 percent have prevailed in recent years and even an annual growth rate of 18 percent over the last 16 years, it is felt that rates this large will not continue far into the future, mainly because of starting from the much larger base of almost 6 million visits in 1975-76. Projections based on regression and three-stage-least-squares analysis gave a range from 6.9 to 8.5 million visits in 1980-81 and 7.7 to 9.7 million in 1985-86. A projection based on analysis of population trends and changes in number of times skiers participate in the sport in a season was 8.2 million visits in 1980-81. Dr. George Sadler's long-range projections varied from 7.1 million to 11.9 million in 1980-81 and 16 million to 18 million in 1985-86.

Projections are based on the assumption that relationships in the past will continue, that average conditions will prevail, and that all other factors will remain about the same. A season like the early part of 1976-77, when snow conditions were the worst in recent history, cannot be foreseen and will throw off projections. However, even such a disastrous year for the Colorado ski industry provides data for future modlers to show the potential effects of a poor snow year.

One of the main values of making projections is in learning more about the structure of the industry. The present report shows a strong, positive correlation between capacity (vertical transport feet) and visits and between the number of college educated people and people in professional, managerial, and technical positions and the number of visits. Visits were negatively related to price of lift tickets and cost of air transportation.

Another result of the study is that if proficiency of skiers continues to increase, it may result in the need for 7 percent more slope area by 1980 to provide the present quality of skiing to a more proficient clientele.

Studies always indicate a need for more data. It would be possible to make better projections if more accurate data were available on prices, such as all-day, half-day, adult, child, and season passes, etc.; home location of skiers; number of times skiers ski per day and per year; and factors that make the trip enjoyable or unpleasant. Also, basic research into the benefits that skiers derive or feel they derive from their sport provides a strong rationale for maintaining or expanding the industry.

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APPENDIX 1

PROJECTION MODEL (5 AND 10 YEARS) USING 16 YEARS OF DATA (1960-61 THROUGH 1975-76)*

A. Rationale of Projection Model I

1. The Origin of Capacity Projection Models

This projection model--Model I to project LTS for 5 and 10 years ahead--has been constructed along the lines used by a group of economists for the National Planning Association in developing a capacity projection for the year 1950. Their model provided measures which gave a benchmark for a set of income and expenditure projections incorporated in the NPA pamphlet National Budgets for Full Employment. The American Economy in 1960 by Gerhard Colm made use of a similar type model. The model was used in 1952 by the President's Materials Policy Commission (the Paley Commission) to project the capacity of the economy in 1975 so as to provide a framework for estimating the Nation's future materials requirements.[1]

The staff of the Congressional Joint Economic Committee (created the Employment Act of 1946 at the same time as was the Council

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*This was a mimeographed report submitted to the Forest Service by Dr. George Sadler.

[1]Resources for Freedom, U.S. Chamber of Commerce, President's Materials Policy Commission, 1952, Vol. II, Chapter 22, pp. 111-116.

of Economic Advisors) published a normal full-employment capacity projection for 1965 (done in 1954).[2] Dr. Robert Turner, University of Indiana, developed national benchmarks for certain regional and State estimates by applying this method.[3] An interesting and elaborate set of capacity forecasts and projections were prepared by the economics department of the McGraw-Hill Publishing Company and presented at the hearings of the Congressional Joint Committee.[4]

The long-run estimates are expressed as a prediction of capacity in a particular future year, yet they actually are forecasts or projections of average annual capacity changes during the intervening period. This is so because the analyst knows very little about what the change in capacity between, say the ninth and tenth year of a 10-year projection, will be.[5]

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[2] Potential Economic Growth of the United States During the Next Decade U.S. Department of Commerce, Joint Economic Committee, 1954.

[3] Robert C. Turner, "The American Economy in 1970," Appraisal Journal, Vol. 2, No. 2, pp. 165-172, April 1956. Also, see _____. Indiana's Economic Resources Potential: A Projection to 1970, Indiana University Bureau of Business Research, Bloomington, Indiana, 1956, Vol. I.

[4] World Economic Growth and Competition, Hearings Before a Subcommittee of the Joint Economic Committee, 84th Congress, 2nd Session, December 1956, pp. 6- , testimony of Dexter Keezer.

[5] Looking ahead to the framework which will be used to build a projection model for LTS, recall that, with supply being treated as predetermined for a 1 year forecast, LTS = SS (supply of lifts which is some proportion of capacity output potential of lifts).

The model's validity rests on the assumption that, over the 5-, 10-, or 15-year period, there will average a rate which, when compounded, will produce about the level indicated for the most distant year. Note that even an abnormal change in the last year will not throw off the projection very much if the average annual rate of change throughout the period is correctly estimated. The statement depends upon the abnormal years averaging out, which means that such estimates become less reliable as the target date is moved towards the present. If this conclusion holds, then typically a 10-year projection would likely be more accurate than a 5-year projection.[6] Two other forecasts must be considered as the target date is extended into the future:

(1) The less trustworthy are the indicators which current and past evidences provide as the greater average remoteness of the forecast period; and,

(2) Reliability tends to be positively correlated with the duration of the forecast period; i.e., a prediction (e.g., a projection) of the total or average annual

[6]Note that the Projection Model I, projecting LTS, has the capacity for making both 5- and 10-year projections, while Model II, as it is constructed, can only be used to make a 5-year projection.

capacity change during the period from 5 to 14 years in the future is apt to be much better than a projection of the change in the particular middle year of the period.

John P. Lewis[7] has expressed the belief that the combined effect of these two influences just mentioned would tend to make the quality of projections of average annual changes in capacity for periods extending not less than 5 years into the future or more than 10 to 15 years distinctly superior to projections for substantially low periods or for single years ahead (forecasts).[8]

2. The Skeleton of the Capacity Projection Model

To bring to conclusion and its use a capacity forecasting and projection model of the type being discussed combines the estimates of average annual percentage changes in the labor force, in working hours, and in productivity into a "composite" average annual rate of change compounds this total annual percentage change the desired number of years and applies the result to the dollar volume of capacity at the beginning of the period.

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[7] John P. Lewis, Business Condition Analysis (New York: McGraw-Hill Book Company, Inc., 1959). See section on "Forecasting Normal Capacity," pp. 372-381, in Chapter 17, commencing An Opportunistic Outlook Model, pp. 371-388.

[8] It is for this reason, among others, that a 5-year projection model, Projection Model II, was developed.

The algebraic form of these related factors is more concise and one can more quickly grasp the nature of the model:

$$(I + r) = (I + r_{\ell})(I + r_h)(I + r_a)$$

Where:

$(I + r)$ = The composite average annual rate of change
r_{ℓ} = The average annual percentage change in the labor force
r_h = The average annual relative change in working hours
r_a = The average annual percentage change in labor productivity

B. Constructing a Projection Model for LTS Along the Lines of the Capacity Projection Model (Where For a Period Ahead LTS = SS = $k_q Q$)

1. A Projection Model for LTS Applying the Principle of the Capacity Projection Method

A single equation for LTS was fitted, regressing LTS against NT, ND, C, I, Ø, E, Z, and P to determine the variables to include in the projection model for LTS and to discover the proportions that each of such variables accounted for the variation in LTS.

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[9] Alternately, the estimated annual change in each of the three determinants of capacity may be compounded separately, the result, e.g., the target-year labor force as a percent of the base-year labor force, converted into absolute terms for the target year, and then these results multiplied together (men times man-hours per year times value of output per man-hour) to yield a dollar volume of capacity in the target year. Cp. cit., John P. Lewis, p. 379, Footnote 11.

The estimated equation that was obtained:

$$\log LTS_t = 6.92460 + 3.57959 \log ND_t + 2.51093 \log \emptyset_t + 4.67336 \log E_t - 1.93393 \log Z_t - 1.18945 \log P_t$$

(Std. Dev.)	(0.36652)	(0.03117)	(0.03838)	(0.03973)	(0.04467)	(0.08788)
[Computed t-value]		[3.167265]	[4.820083]	[5.244035]	[-13.39529]	[-3.05483]

A straightforward translation of the principle implicit in the construction of the capacity projection model would obtain the following model, recognizing the variables isolated in the fitted equation as the most relevant of those specified:

$$(I + r_{LTS}) = (I + r_{ND})\ (I + r_{\emptyset})\ (I + r_E)\ (I + r_Z)\ (I + r_P)$$

It is proposed that a weighted average form of this straightforward translation of the capacity model applied for LTS would bring about an improvement in projections because the relative importance of each regressor variable would be recognized and reflected in terms of how much each has accounted for variation in LTS (as shown by the results of the fitted equation for LTS above).

The standard deviations of the respective variable were used to standardize or normalize each partial correlation coefficient for the variables of the fitted single-equation for LTS. Using these results, an index was prepared (ignoring the estimated value of the constant term which had a weight of $|-5.84988|$), to determine the relative weights of each variable in the fitted equation.

Variable	Standardized Partial Correlation Coefficient	Index of Weights
NT_t	$\|31.84988\|$	$\|33.61092\|$
$\emptyset_t$	$\|14.52671\|$	$\|15.32996\|$
E_t	$\|32.62286\|$	$\|34.42664\|$
Z_t	$\|-12.00704\|$	$\|-12.67097\|$
P_t	$\|-3.75376\|$	$\|-3.96123\|$
	94.76025	100.00

A weighted average form of the projection model has been prepared along the lines suggested by:

$$(I + r_{LTS})_{wavg} = \{[(I + r_{NT})(W_{NT})] [(I + r_{\emptyset})(W_{\emptyset})] [(I + r_E)(W_E)] [(I + r_Z)(W_Z)] [(I + r_P)(W_P)]\} / \text{Sum of Weights}$$

$$(I + r_{NT})(W_{NT}) = (1.0129)(33.61092) = 34.04450$$

$$(I + r_{\emptyset})(W_{\emptyset}) = (1.0160)(15.32996) = 15.57524$$

$$(I + r_E)(W_E) = (1.0185)(34.42664) = 35.06353$$

$$(I + r_Z)(W_Z) = (0.98654)(12.67097) = 12.50042$$

$$(I + r_P)(W_P) = (1.0334)(3.96123) = 4.09354$$

$$\text{Log } (I + r_{LTS})_{wavg} = \log 34.0445 + \log 15.57524 + \log 35.06353 + \log 12.50042 + \log 4.09354$$

$$= \frac{3.52777 + 2.74555 + 3.55720 + 2.52570 + 1.4094}{100}$$

$$= \frac{13.76550}{100}$$

$$= 0.137655$$

$$(I + r_{LTS})_{wavg} = \text{antilog } 0.137655$$

$$= 1.1475$$

Compound $(I + r_{LTS})_{wavg} = 1.1475$ for 5 years to get the factor to multiply times the average for the five most recent years of LTS, namely, 1971-72 through 1975-76, which is 4546.3 to compute the projection for 5 years for LTS.

$$\widehat{LTS}_{t+5} \quad (80\text{-}81) = (1.1475)^5 \text{ (LTS for most recent 5-year average)}$$

$$= (1.9895)\ (4546.3)$$

$$= 9{,}044.9$$

Note that if LTS = 5,971.9 (in 1975-76) were used with $(1.1475)^5$, a projected value of 11,881.1 would be obtained for a 5-year projection for LTS (1980-81).

Simple average annual rate of change for LTS, obtained by using the compound interest formula, is $(1 + r_{LTS}) = 1.1529$, which when compounded for 5 years and multiplying a 5-year average of LTS (from 1971-72 through 1975-76) of 4546.3 obtains:

$$\widehat{LTS}_{\substack{t+5 \\ (80\text{-}81)}} = (1.1529)^5 \ (4546.3)$$

$$= (2.0368) \ (4546.3)$$

$$= 9259.9$$

2. A Modified Form of Projection Model I Using $[(I + r_{LTS})_{wavg}$ -- ~~a~~].

A modified form of this weighted average projection model can be obtained by recognizing that the arithmetic mean reflects all extreme values, while the harmonic mean is typically smaller than the geometric mean (the geometric mean is less than the arithmetic mean) for any series of unequal positive values. The harmonic mean is useful when data are expressed in terms of rates. The harmonic mean is based on all observations in the data and is affected by them, yet it gives less weight to the extremely large values than does the geometric mean and gives more weight to the small values than do either the arithmetic or the geometric mean. Another important characteristic of the harmonic mean is that it lends itself to further algebraic manipulation.

It is proposed that simple methods of determining rates of change which are of data assuming a curvilinear form in nature miss the target the longer the period of projection; therefore, some adjustment for this known fault appears to be justified. As an example, let's develop a term which is called alpha(α), which will be used to make a modification to the $(I + r_{LTS})_{wavg}$ in order to mute or to attenuate purposely the magnitude of the projection which would otherwise occur.

Using a 5-year moving average taken over the 16 years' data yields 12 years of constructed data from 1962-63 through 1973-74 with the $\overline{X}$ = 2,171.3 and H = 2,142.9 of the LTS data for the 12-year series.

$$\begin{aligned} \overline{X} &= 2{,}271.3 \\ H &= \underline{2{,}142.9} \end{aligned}$$

$$(H - \overline{X}) = -28.4$$

Relating $(H - \overline{X})$ to $\overline{X}$:

$$-0.01308 = \frac{-28.4}{2171.3} = \frac{(H - X)}{\overline{X}} = \alpha$$

Using $(I + r_{LTS})_{wavg} = 1.1475$ and modifying this value by $\alpha = -0.01308$

$$\begin{aligned} (I + r_{LTS})_{wavg} &= 1.14750 \\ \text{Less } \alpha &= \underline{-0.01308} \\ (I + r_{LTS})_{wavg}) - \alpha &= 1.13442 \end{aligned}$$

Compound this modified factor by 5 years:

$$(1.13442)^5 = 5 \log (1.13442) = 5(0.12612) = 0.6306$$

$$= \text{Antilog } 0.6306$$

$$= 1.8787$$

Using this figure to calculate:

$$\widehat{LTS}_{t+5} = [(I + r_{LTS})_{wavg} - \alpha]^5 \quad \text{(LTS for 5-year average:}$$

(80-81) 1971-72 through 1975-76)

$$= (1.8787)\ (4546.3)$$

$$= 8537.9$$

Recall using the unmodified $(I + r_{LTS})_{wavg}$ compounded by 5, obtaining

$$\widehat{LTS}_{t+5} = 9044.9$$

(80-81)

3. Using Model I to Project 10 Years Ahead

Compounding $(I + r_{LTS})_{wavg} = 1.1475$ by 10 years, obtains a factor of 3.9582. Multiplying this factor times the average of LTS for the five most recent years (1971-72) through 1975-76), which is 4546.3, the 10-year projection may be calculated:

$$\widehat{LTS}_{t+10} \quad = (3.9582)\ (4546.3)$$
$$(85\text{-}85)$$
$$= 17{,}995.2$$

Using the modified form, $[(I + r_{LTS})_{wavg} - \alpha] = 1.13442$ compounded for 10 years obtains 3.5296, and the modified form calculates a 10-year projection of:

$$LTS_{t+10} \quad = (3.5296)\ (4546.3)$$
$$(85\text{-}86) \quad = 16{,}046.6$$

5-YEAR PROJECTION MODEL II FOR LTS USING

12 YEARS OF DATA (5-YEAR MOVING AVERAGE)

A. The 5-Year Projection Model--Estimated Single-Equation Using 5-Year Average Data

Using 12 years (62-63 through 73-74) data of 5-year moving average data, a single equation for LTS was estimated. The best fit was obtained using logarithmic data. The estimated single equation for LTS obtained was:

$$\log LTS_t = -3.79760 + 1.21167 \log ND_t + 1.26318 \log I_t + 5.18823 \log \emptyset_t - 1.94492 \log Z - 1.84717 \log P_t$$

(1.24958)* (4.64969) (7.68077) (-14.700) (-2.82192)

The parentheses ( ) contain the computed t-values of beta coefficient d.f. = n - (k + 1) = 12 - (5 + 1) = 6

Critical t-value = 1.943 d.f. = 6; @ α = 0.05

*This computed t-value is less than the critical t-value; however, this variable ND_t accounts for over 20 percent of the variation in LTS and, when it is omitted, the results are much poorer for all practical use of the estimated equation. For these reasons, ND_t was not omitted from the equation.

B. Estimating the 5-Year-Ahead Values of Regressor Variables to Make 5-Year Protection of LTS for 1980-81

Using the logarithmic form of the compound interest formula, $S = P(1 + r)$, which is $(1 + r) = \text{antilog}[(\log S - \log P)/n]$, each of the variable regressors ND_t, I_t, $\emptyset_t$, Z_t, and P_t were calculated. Then, these rates of change were compounded for 5 years; e.g., $(1 + r_{ND})^5 = 5 \log (1 + r_{ND}) = 5 \log (1.0138) = 1.071$. Then, this $(1 + r_{ND})^5 = 1.071$ was used to multiply the most recent 5-year moving average value for the variable ND_t which was, for 1973-74 = 111.3. Thus,

$$\widehat{ND}_{t+5} \quad (80\text{-}81) = (1 + r_{ND})^5 (ND_t = 1973\text{-}74)$$

$$= (1.071)\ (111.3)$$

$$= 119.2$$

The 5-year ahead values for all five variable regressors were estimated in this way:

Variable Regressor	t + 5 (80-81) Estimated Value
ND	119.2
I	1,279.2
$\emptyset$	27.3
Z	44.3
P	44.17

It is convenient at the point of discussion to note the estimated values of LTS for a 5-year period ahead to 1980-81 when calculated by the compound interest formula in log form using two sets of data:

(a) 12 years of 5-year moving average data, and

(b) 16 years of observed data

	12 Years of Data (5-Year Moving Average)	16 Years of Observed Data
(a) $\widehat{LTS}_{t+5}$ (80-81)	9,181.1	
(b) $\widehat{LTS}_{t+5}$ (80-81)		9,259.9

C. Using the "5-Year Projection Model II" to Project LTS 5 Years Ahead to 1980-81

$$LTS_{t+5} \text{ (80-81)} = -3.7976$$

$$+ 1.21167 \log ND_{t+5} = 1.21167 \log (119.2) = 1.21167 (2.07628) = +2.5157$$

$$+ 1.26318 \log I_{t+5} = 1.26318 \log (1279.2) = 1.26318 (3.10694) = +3.9246$$

$$+ 5.18823 \log \emptyset_{t+5} = 5.18823 \log (27.3) = 5.18823 (1.43616) = +7.4511$$

$$- 1.94992 \log Z_{t+5} = 1.94992 \log (44.3) = -1.94992 (1.64640) = -3.2103$$

$$- 1.84717 \log P_{t+5} = -1.84717 \log (44.17) = -1.84717 (1.64513) = -3.0388$$

$$+3.8547$$

$$\widehat{LTS}_{t+5} = \text{Antilog } 3.85474$$

$$\text{(80-81)} = 7,157.1$$

SUMMARY OF RESULTS FROM APPLYING
PROJECTION MODELS I AND II

A. Five-Year Projections By All Models

1. Projection Model I:

(a) Using 16-year data	LTS_{t+5} (80-81)	= 9,044,900
(b) Using 16-year data and modified form of Projection Model I with $[(I + r_{LTS})_{wavg}$ -x]	LTS_{t+5} (80-81)	= 8,537,900

2. Projection Model II:

Using 12 years of 5-year moving average data	LTS_{t+5} (80+81)	= 7,157,100

3. $(1 + r)$ = Antilog [logS-logP)/n] Method:

Using the compound interest formula to calculate $(1 + r_{LTS})$ = 1.1529 and with 16-year data	LTS_{t+5} (80-81)	= 9,259,900

B. Ten-Year Projections Using Projection Model I

1. Using Unmodified Form of Model I	LTS_{t+10} (85-86)	= 17,995,200
2. Using Modified Form of Model I with $[(I + r_{LTS})_{wavg}$ -x]	LTS_{t+10} (85-86)	= 16,046,600